

Fun Functions

Brief Overview:

This lesson unit addresses the process for solving missing numbers in function tables. It guides the students to realize the relationship between an input number and an output number. In addition, this unit gives the students the tools to successfully create a function table when given real life data.

NCTM Content Standard/National Science Education Standard:

- Understand patterns, relations, and functions.

Grade/Level:

4

Duration/Length:

- Three 60 minute class periods.

Student Outcomes:

Students will be able to:

- Understand the relationship between the input and output numbers.
- Calculate the missing input and output numbers in a function table when given the rule.
- Identify the rule in a function table when given at least three pairs of input/output numbers.
- Calculate the missing input and output numbers in a function table when given at least three pairs of input/output numbers.

Materials and Resources:

- Preassessment function table (Student Resource 11) – one per student
- Answer sheet for preassessment (Teacher Resource 4)
- Manipulatives (chips, blocks, etc.) – enough for partner work
- Overhead of a function table with three columns (Teacher Resource 1)
- Overhead of a function table with two columns (Teacher Resource 2)
- Page with large three column function table (Student Resource 1) – one per pair
- Page with large two column function table (Student Resource 2) – one per pair
- Sheet with blank three column function tables (Student Resource 9) – one per student
- Sheet with blank two column function tables (Student Resource 10) – one per student
- Two Containers (for activity one)
- Input cards with numbers 1-9 (Student Resource 3) – one per pair
- Blank input cards (Student Resource 6) – one per pair
- Rule cards with assigned addition rules (Student Resource 4) – one per pair
- Rule cards with assigned subtraction rules (Student Resource 5) – one per pair
- Rule cards with assigned multiplication rules (Student Resource 7) – one per pair

- Blank rule cards (Student Resource 8)
- Clear page protectors – one per pair
- Dry erase markers – one per pair
- Book: “One Grain of Rice” by Demi
- Entrance Slip for Lesson 2 (Student Resource 19) – one per student
- Answer sheet for Entrance Slip for Lesson 2 (Teacher Resource 3)
- Note cards – two per pair
- Sheet for food buying activity (Student Resource 16) – one per student
- Answer sheet for food buying activity (Teacher Resource 6)
- Pictures/Prices sheet for food items (Student Resource 17)
- School supply ads – enough to share
- Scissors
- Glue
- School supply activity sheet (Student Resource 20) – one per student
- Input/Output sheets for manipulative stations (student resource 12) – one per pair
- Sheet to record information for manipulative stations (student resource 13) – one per student
- Car activity sheet (student resource 14-15) – one per student
- Answer sheet for car activity sheet (Teacher Resource 5)

Preparations to be made prior to Lesson:

- Copy and cut input cards (Student Resource 3) and place in a container (a bag will work).
- Copy and cut rule cards (Student Resource 4) and place in a container.
- Create an overhead of the both function tables (Student Resource 1 and 2).
- Create enough bags of rule cards and input cards (Student Resource 3-6) to be used for Function Game (1 for every 2 students). You may want to make sets using the blank cards to challenge some students.
- Copy pictures/prices of food papers (Student Resource 17) to post around the room.
- Copy sheet for food buying activity (Student Resource 16 a and 16 b front to back).
- Copy enough input/output manipulative station sheets (Student Resource 12 and 18) for stations so that ever two students have a station to visit.
- Copy sheets for recording manipulative stations (Teacher Resource 13).
- Copy car activity sheet (Teacher Resource 14-15).

Development/Procedures:

Lesson 1

Pre-Assessment

- Students will be given a completed function table that is missing the rule (Student Resource 11).
- At the bottom of the sheet the students will be asked to answer the following: What do you think happens to the number in the input column to get the number in the output column? Explain your thinking.
- Circulate during the independent time observing the students and assessing their understanding of the concept by reading their responses.
- Once the students have had a chance to answer independently they will share their ideas with a small group. The group will decide what to share with the class. *Possible responses might*

include: I added two to the input number to get the output number. This happened every time.

- Then ask what the relationship is between the input and output. If students seem confused by the word “relationship” remind them that the relationship would not change. It would stay the same. The students would then notice that the rule in their table did not change either. Guide them to see that the changes to the input number to get the output number is called the relationship between the input and output and this is also called the rule”.

Launch (5-6 minutes)

- Ask a student to volunteer (we will call this student Billy for this explanation). That student comes to the front of the room. In your overhead function table write 1 under input (Teacher Resource 1).
- Tell the students that Billy is having a party. His mom will let him invite two people. Billy will then go choose two people from the class.
- Ask: What goes in the middle column? The students will answer “+ 2.”
- Ask the class how many children are going to Billy’s party including Billy. The class will say “3” so this number needs to be written under the output column.
- Then write 3 in the input column because this is the number of students we are starting with now.
- Now there are 3 people going to the party. Billy’s mom says he can now invite 2 more people so Billy chooses 2 more students from the class.
- Ask: What goes in the middle column? (plus 2).
- Now ask what goes in the output column (how many total people are going to Billy’s party). The answer is 5.
- At this point ask: “Why is the last output number the same as the new input number?”
- Have students think about the question, pair up with a partner, and share their ideas.
- Ask volunteers to share their thoughts about the question.
- The students should discover that the only reason the last output number is the same as the new input number is because we are continuously adding more to our total. Draw their attention to the preassessment when the output was not the same as the next input.
- Continue adding to Billy’s party group until the students discover the relationship between the number of students that were already going to the party and the new number of students going to the party.

Teacher Facilitation

- Display an overhead of a function table (Teacher Resource 1). Note: You may choose to draw a function table on the board instead. The purpose of the three column function table is to allow the students to discover that the operation used for each pair remains the same throughout the entire function table. In lesson 2 you will have the students’ progress from using the three column table to a two column table (See Teacher Resource 2).
- Each pair of students will have the same function table at their seats (Student Resource 1) as well as a bag of input numbers and rule cards (Student Resources 3-5). The function table sheet needs to be put in a clear page protector so students can write on it with a dry erase marker.
- Have a student and randomly draw a card from the rule bag.
- The students will find the rule in their bags and put it at the top of their chart.
- Another volunteer can come and draw an input card and write it in the chart as the other students fill in their chart at their seats.

- Ask the students what goes in the middle column (They should say the rule).
- Then ask how they can figure out the output. Give groups a chance to think about the question and share with their partner.
- Give pairs time to find and write what they think the output number is in the output column with their dry erase marker.
- Have volunteers share the answer they found.
- Then ask the students, “What is the relationship between the input and the output”. They should remember from earlier in the lesson that the relationship is the same as the rule.
- This can be done several times using the same rule.
- The students will then continue with the same rule. Pairs will draw a new input number and solve for the output.
- During this time circulate with a clipboard and cards with students’ names on them. Take notes on each student’s ability to find the output easily and correctly as opposed to those who are struggling (informal assessment).

Student Application

- Students will now have the opportunity to try it on their own by playing the Function Game.
- During this time pull a small group for re-teaching based on the informal assessment (The notes taken during the guided activity is the informal assessment.).
- Students will work with a partner. They will need a function table sheet (Teacher Resource 9 and/or 10) and a bag of rule cards and input cards. Students can choose from easier rules or more challenging rules (You can make multiplication rules or rules adding larger numbers) depending on the ability of the students.
- One student in each pair will choose a rule card and both students will write it in their chart.
- The next student will pull an input card from the bag and both students will write it in their chart.
- Next, each student will calculate the output on a piece of paper or using manipulatives.
- Students will compare their answers. If they match they will write them in the chart. If they do not match they need to figure out what went wrong.
- The object of the game is to work together to fill in their function table. Students can play as many times as they want challenging themselves to choose a more difficult rule each time.

Embedded Assessment

- Observe the groups as they play the function game to identify the students who understand the relationship between the input and the output numbers.
- You can also assess the students during small group instruction for re-teaching.

Reteaching/Extension

Challenge:

- Challenge students with more difficult rules or larger numbers in the function table.
- This can be done with the blank input cards and blank rule cards. Put larger (two digit) numbers for input cards or use multiplication rules to challenge some students.

Reteach:

- Students who are still struggling after whole group (based on informal assessment), can be placed in a small group and continue working.
- Give each student their own copied function table (Student Resource 1) and a set of manipulatives (chips, blocks, etc.)
- Guide the students by giving them a rule for their table such as $+3$.

- Then guide the students by giving them the first input and output pair of 2 (input) and 5 (output).
- The students will put 2 blocks under the input column and 5 under the output column.
- Ask: “What relationship do you notice between the 2 and the 5?” (Students should see the rule $+3$).
- Continue by giving the students only the input number. If there are 4 blocks under input how many blocks should we add? If we add 3 blocks how many are under the output?
- Continue making input numbers and guiding the students to discover the output.
- Now ask the students: “what if you increase your rule by 1? What will happen to your output?” (*Possible answers include: the output will increase or the output number will be more*).
- Ask the students: “What if you decrease the rule by 1? What will happen to your output?” (*Possible answers include: the output will decrease or the output number will be less*).
- Once students are more successful change the rule and progress to using numbers instead of manipulatives.

Lesson 2

Pre-Assessment

- Entrance Slip (Student Resource 19): How do you know that an operation is a rule for a function table?
- Post the overhead function table (Teacher Resource 1) so students have a visual to refer to as they answer the question.
- *Possible response: In a function table you find out what you do to the input number to get the output number as your answer. If you do the same thing to each input number to get the output number it becomes the rule for that function table.*

Launch

Read “One Grain of Rice” by Demi. As you read, stop periodically to emphasize the relationship between the number of grains and how many total grains of rice after doubling them. This is an introduction into multiplication in function tables.

Teacher Facilitation

- Once you have read the story it is time to relate this concept to the students. Ask the students what types of food they like to eat on a regular basis.
- Students may say things like cereal, milk, bread, cookies, etc. Choose one of the items listed. Let’s take milk for example. Ask the class how much milk they think they drink in a week. Let’s say they agree on 2 gallons.
- Then ask the class, “If milk costs about \$4 (an estimated value to eliminate decimal values) a gallon and you are buying 2 gallons, how much money have you spent?” (*The class will answer \$8*).
- Ask partners to figure out how these numbers would fit into a three column function table. The students will work together to create this on a blank piece of paper. (Put the three column function table (Teacher Resource 1) on the overhead for students to refer to).
- Now ask the students, “What if we decided to buy 5 gallons of milk? What would be the output now?” (*The students should discover that the outcome is \$20*).

- Ask the students why the outcome is different when we bought 5 gallons. *Possible answers: the rule is always going to be multiply by 4 and 4 times 5 is 20.*
- Repeat this process one more time telling the kids to buy 3 gallons of milk. The outcome should now be \$12.
- Once groups have completed the three column function table ask how a two column function table would look different.
- Put a two column function table (Teacher Resource 2) on the overhead and have a volunteer fill in the numbers from the milk problem.
- Give partners a chance to discuss what is different between the two tables. The students should see that the only difference is the rule is not written each time. Instead it is written at the top of the function table.
- Ask the students if the relationship between the input and the output has changed from one function table to the other? The students need to justify their answers. They should realize that the relationship does not change.

Student Application

- Now the students will have the opportunity to apply their knowledge. Post items around the room with the price for each item listed (The prices that have decimals can be a challenge for some students. If students have difficulty multiplying they can use a calculator.).
- The students will be shopping for items they wish to buy. Each student will be given a paper with four function tables (Student Resource 16a and 16b). Each function table will be used for one item that the students find in the room.
- The function table will have a place to write the item the students bought, the cost of the item, the rule, and the input and output values. The students will need to decide where the numbers they have belong in the table and what numbers they are calculating to find.
- Students will work with their partner to choose four items in the room and fill in the corresponding function table to show the cost of buying various quantities of that item.
- Once the students have completed this part of the activity they will return to their seats and reflect on their learning. The students will have questions on the back of their paper to answer (Student Resource 16a and 16b copied front to back).
- The questions will include: 1. How did you decide what numbers fit into the different sections of your function table? 2. How did you determine the relationship between the input and the output? 3. Which item would your parents buy on a regular basis? Why?
- *Possible answers: 1. I thought that the number of items I wanted to buy would be what I start with so that is the input. The output would increase the more items I bought. 2. I knew that the more I bought of an item the greater my output. Every time I bought more of that item I had to count the cost that many more times. That means I am multiplying the cost and the number of that item I bought. 3. I think my parents would buy milk even though it is expensive because it is good for me. It is about the same price as cookies but cookies are not good for me.*
- Have some students share their responses to the reflection question.
- Now the students will each get an ad for school supplies. They will choose one item from the ad that costs at least \$1.51 (so that it rounds to at least 2 dollars) and cut it out.
- The students will then round the price of the item to the nearest dollar (a quick review of rounding may be needed). For example: if the item costs \$2.25 the 2 in the tenths place tells the 2 in the ones place to stay the same so it rounds to \$2.

- The students will glue their item on their half sheet (Student Resource 20). They will write the price of the item in the space provided. They will also write the rounded price for the item in the space provided.
- Explain that the student's first input number is the total number of students in the class because they are pretending you will be buying that item for each and every student.
- The students will then calculate the cost of buying that same school supply for different sized classes (the input numbers for the other columns will already be filled in).
- The question at the bottom of the page will ask: What are the advantages of having a smaller class size?
- *Possible answers: A teacher will spend less buying supplies for a smaller class or the students in a smaller class will get more things.*
- Students will independently answer the question and then share their responses.

Embedded Assessment

Collect the school supply activity sheet to assess the students for the day.

Reteaching/Extension

- Students are left to choose the input values in their function table during the partner activity. They can choose smaller values if they have difficulty multiplying large numbers. Students who need a challenge can be encouraged to choose larger input values.
- Circulate during the activity and assisting any groups that are having difficulty. Students who struggle with their math facts should use a calculator or multiplication grid.

Lesson 3

Pre-Assessment

Students will complete a function table with a multiplication rule. This will be graded quickly so you can identify students who are still struggling with the concept.

Teacher Facilitation

- Set up various stations (Teacher Resource 12 and 18). Each station needs pairs of manipulatives. For example, you could have 2 blocks next to 4 blocks. At another station there could be 5 blocks next to 15 blocks.
- You could also have index cards with rules that correspond to the rule that matches the block pairs. For example, $+ 2$ or $\times 3$.
- The students would also have a piece of paper with a function table (Student Resource 13) that gives students a place to draw a picture of each set of manipulatives and the rule.
- Give pairs of students a rule card. Their job would be to find the block pair that matches their rule. Note: Give more challenging rules to more advanced students and vice versa.
- An example of something the students might see includes:

OO	OOOOO
OOOO	OOOOOOO
OOOOO	OOOOOOOO

The rule card that would match would be $+ 3$.

- Once students discover the visual representation of their rule they will write the values in the first function table on their sheet (Teacher Resource 13).

Student Application

- Now the partner pairs will have a chance to create their own pair of manipulatives to match a rule of their choice. They will write the rule they have made up on an index card but they will not tell anyone what their rule is.
- The students will then be given a pile of manipulatives. They will create three pairs that match the rule they decided on.
- The students will need to place their sets of manipulatives at a station.
- Then collect all the rule cards. Redistribute them, making sure groups do not receive the rule they created.
- Partners will circulate the room again looking for the stations that represent the rule they have received.
- This activity can be repeated by collecting the cards and redistributing them as many times as you wish. Students can also create more rules and sets of manipulatives to match.

Embedded Assessment

Students will complete the summative assessment at the completion of this lesson to show their overall understanding of relationships between numbers and input and outputs.

Reteaching/Extension

- Differentiate by giving groups who need a challenge a more difficult rule. The same can be done for struggling students by giving them an easier rule.
- When redistributing rules look to make sure the group you give the rule to can be successful. You may want to pair students heterogeneously so that they can help one another.
- If students are having difficulty assist those groups by helping them look at each station. The students can write the input and output numbers and identify the rule together to decide if it matches their card.

Summative Assessment:

Students will receive a paper with the following scenario written on it (Student Resource 14-15):
The cost of gas is increasing in America. When choosing a car to drive you want to think about how much it costs to fill up your tank. The chart you will create should show the relationship between the number of gallons in a tank of gas and the cost to fill up that tank. It costs approximately \$4.00 to put one gallon of gas in your car. (Note: If the cost of gas is closer to another whole number value you can change the question to accommodate this. Use a whole number so students do not need to multiply by decimals.) The students will be given the name of the car and the size of the tank.

The students job is to fill in the rule (which is multiply by 4 or \$4 or to multiply by whatever money value you have given them for the cost of one gallon of gas). They will need to decide which are the input numbers (the size of the tank) and calculate the output based on the rule. Students will be successful if they correctly fill in 4 out of 5 input/output pairs as well as the correct rule.

In addition, at the bottom of the page students will have a reflection question. The question will state: Which vehicle would you rather put gas in? Why? Logical answers for this question would include the

vehicle with a smaller tank because it would cost less to fill or the vehicle with the larger tank because you wouldn't need to fill it as often.

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Input	Rule	Output

Input	Output

Input cards for Activity 1		
2	3	4
5	6	7
8	9	

Rule cards for Activity 1		
$+1$	$+2$	$+3$
$+4$	$+5$	$+6$
$+7$	$+8$	$+9$

Rule cards for Activity 1		
-1	-2	

Input cards for Activity 1		

Rule cards for Activity 1		
$\times 2$	$\times 3$	$\times 4$
$\times 5$	$\times 6$	$\times 7$
$\times 8$	$\times 9$	$\times 0$

Rule cards for Activity 1		

Input	Rule	Output

Input	Rule	Output

Input	Output

Input	Output

Input	Rule	Output
2		4
4		6
7		9
10		12

What do you think happens to the number in the input column to get the number in the output column?

Explain your thinking.

Input

Input

Rule

Output

<div>Example</div> <div> O O OOOO OOOOO</div>	<div>+ 000 +000 +000</div> <div>+3</div>	<div> OOOOO OOOOOOO OOOOOOOOO</div>
<div></div> <div>_____</div> <div></div> <div>_____</div> <div></div> <div>_____</div>	<div></div> <div>_____</div> <div></div> <div>_____</div> <div></div> <div>_____</div> <div></div> <div>_____</div>	<div></div> <div>_____</div> <div></div> <div>_____</div> <div></div> <div>_____</div>
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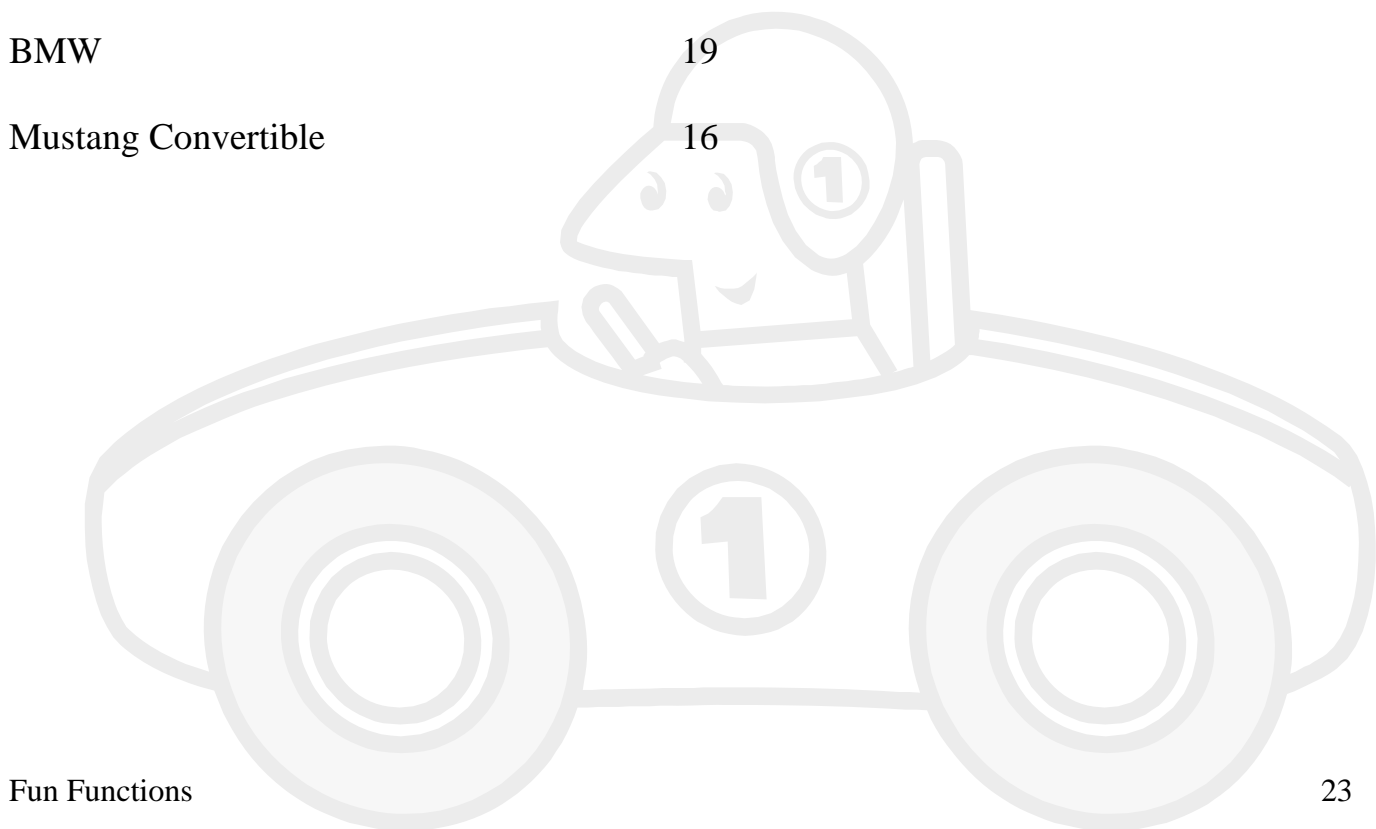
Name _____

Date _____

Directions: Read the following paragraph. Identify the input number. Identify the rule that will be used. Put the input numbers in the correct place in the function table.

The cost of gas is increasing in America. When choosing a car to drive, you want to think about how much it costs to fill up your tank. The following chart shows the relationship between the number of gallons in a tank of gas and the cost to fill up that tank. It costs approximately \$4.00 to put one gallon of gas in your car.

Type of car	Size of gas tank
Hummer	32
Honda Civic	12
Escalade	26
BMW	19
Mustang Convertible	16



Name _____ Date _____

Car Name	Input	Output

Rule _____

Which vehicle would you rather put gas in? Why?

Name _____ Date _____

Directions: Choose one food item. Record the cost for the item. Decide how much of the item you would like to buy for the week.

(* If you are going to buy 2 gallons of milk – the number 2 is your starting number – where would you put this in your chart?)

Food Item _____

Food Item _____

Cost _____

Cost _____

Rule _____

Rule _____

Input	Output

Input	Output

Food Item _____

Food Item _____

Cost _____

Cost _____

Rule _____

Rule _____

Input	Output

Input	Output

Student

Answer the following questions based on the information you entered into the function tables on the reverse side of this page.

1. How did you decide what numbers fit into the different sections of the function table?

2. How did you determine the relationship between the input and the output numbers?

3. Which item would your parents buy on a regular basis? Why?

 <p>Milk \$4</p>	 <p>Bread \$2</p>	 <p>Cereal \$3.50</p>	 <p>Hot Dogs \$2.50</p>
 <p>Cookies \$3</p>	 <p>Chicken Nuggets \$6</p>	 <p>Chips \$1</p>	 <p>Pizza \$5</p>

Output

Name _____

Date _____

How do you know that an operation is a rule for a function table?

- - - - -

Name _____

Date _____

How do you know that an operation is a rule for a function table?

Name _____

Date _____

Paste item here

Input	Output
15	
20	
40	
10	

Price of item _____

Rounded price of item _____

Rule for function table _____

What are the advantages of having a smaller class size? _____

Name _____

Date _____

Paste item here

Input	Output
15	
20	
40	
10	

Price of item _____

Rounded price of item _____

Rule for function table _____

What are the advantages of having a smaller class size? _____

Input	Rule	Output

Input	Output

Name _____

Date _____

How do you know that an operation is a rule for a function table?

Possible responses include:

- a. In a function table you find out what you do to the input number to get the output number as your answer. If you do the same thing to each input number to get the output number it becomes the rule for that function table.
- b. If you do the operation over and over again it becomes the rule.

Input	Rule	Output
2	$+ 2$	4
4	$+ 2$	6
7	$+ 2$	9
10	$+ 2$	12

What do you think happens to the number in the input column to get the number in the output column?

Add 2 each time

Explain your thinking.

I can see that $2 + 2 = 4$ and $4 + 2 = 6$. Each time I added 2 and got the number in the output box.

Name _____ Date _____

Car Name	Input	Output
Hummer	32	\$128
Honda Civic	12	\$48
Escalade	26	\$104
BMW	19	\$76
Mustang Convertible	16	\$64

Rule $__ \times 4 ______$

Which vehicle would you rather put gas in? Why?

Possible responses include:

A. Honda Civic because the gas tank is small and it would not cost as much to fill it up.

B. Hummer because it holds more gas, so I would not have to fill it up as often.

Name _____ Date _____

Directions: Choose one food item. Record the cost for the item. Decide how much of the item you would like to buy for the week.

(* If you are going to buy 2 gallons of milk – the number 2 is your starting number – where would you put this in your chart?)

Answers will vary depending on items students choose and the number of each item that the students choose to buy. The following is only an example.

Food Item Milk

Food Item _____

Cost \$4

Cost _____

Rule x 4

Rule _____

Number purchased

Input	Output
3	12
6	24
10	40
8	32

Input	Output

Food Item _____

Food Item _____

Cost _____

Cost _____

Rule _____

Rule _____

Input	Output

Input	Output

Answer the following questions based on the information you entered into the function tables on the reverse side of this page.

1. How did you decide what numbers fit into the different sections of the function table?

I thought that the number of items I wanted to buy would be what I start with, so that would be the input. The output would increase with the more items that I bought.

2. How did you determine the relationship between the input and the output numbers?

I knew that the more I bought of an item the greater my output. Every time I bought more of that item, I had to count the cost that many more times. That means I am multiplying the cost with the number of that item that I bought.

3. Which item would your parents buy on a regular basis? Why?

I think my parents would buy milk even though it is expensive, because it is good for me. It is about the same price as cookies, but cookies are not good for me.
